

The Canadian Entomologist.

LXXII

GUELPH, DECEMBER, 1940

No. 12

THE EFFECT OF HAILSTORMS ON GRASSHOPPERS

BY G. J. SPENCER,

The University of British Columbia, Vancouver, B. C.

The effect of a violent hailstorm on *Camnula pellucida* Sc. was noted at 2:15 P. M. on July 6, 1930, at a time when enough instruments were on hand to make a few records. The area was an observation station on the open range in Chilcotin, British Columbia, at an elevation of 3,400 feet; range cover was slight, consisting of a closely cropped, overgrazed turf of *Poa* running to an alkaline patch of *Distichlis*. The day had been cool, running 63°F. at 10 A. M. to 47°F. at 11:30 and up to 64°F. at 2:15 P. M. when a sudden storm blew up from the west and in a few moments burst with a violent downpour of rain and hail lasting for twenty minutes. The ground was soon white with hailstones which lay in small hollows to a depth of two inches, but averaged one inch deep on the flat. From an air temperature five feet above ground of 64°F. just before the storm, the mercury dropped to 48°F. in fifteen minutes time and at one foot about ground to 44°F., while on the surface under the hail, in the space surrounding the grasshoppers, it was 34°F. The hail did not last very long, and in twenty minutes when the storm ceased it was already beginning to melt and, with the downpour of rain, formed rushing rivulets down every depression and gully.

There was a considerable population of *Camnula* present, both nymphs and adults, and the hail covered them completely. But ten minutes after the storm ceased, they were hopping freely on stony, cactus-covered hillsides nearby on which the hail had formed only a very thin layer. Very soon afterwards, most of the grass and mud-covered flats were also free of hail and many grasshoppers could now be seen lying on their sides, kicking feebly, and a few even taking small leaps. In exactly one hour from the commencement of the storm, when the ground temperature was 63°F. and the air 67°F., the area was buzzing with leaping hoppers except in low spots where pools of water still remained. Not a single grasshopper was found to have been killed. One in the fifth instar was feeble and had an eye bashed in; one, just moulted to adult, soft, with one wing deformed, was lying helpless on one side, and eventually was dragged off by ants. None was carried away by the rain or rush of melting hail into the ravines, so that these two constituted the only casualties that could be found. In one and one-half hours time the ground temperature had risen to 73°F. and all hoppers seemed perfectly normal again.

The relative humidity possibly had nothing to do with the behaviour of the hoppers after the storm but as a matter of record only, it had remained over 90 per cent. from 8 A. M. to 1 P. M., had fallen to 78 per cent. at 2 P. M., and as soon as the storm broke, it shot up to 100 per cent. and remained there until 6 P. M.

A second opportunity to note the effect of a hailstorm on grasshoppers occurred on the afternoon of 19th July, 1939, on the cattle ranges some thirteen miles above Kamloops, at an altitude of 3150 feet. The site was at the junction of open range and timber of aspen and Douglas fir, the ground cover being a dense mat of tall *Stipa* of two species, *Poa*, and weeds including clumps of dandelion. The area supported a sparse population of *M. m. mexicanus* (Saus.) and a few *M. packardii* Sc.

The temperature at 1 P. M. was 69°F. and at 1:40 P. M. it had fallen to 52°F. when the storm started with a tremendous burst of hard-falling hailstones averaging 8-10 mm. in diameter. In ten minutes there was a complete lull for one minute and then the hail fell with renewed vigour. At 2 P. M., when the air temperature was 47°F., the storm stopped abruptly and the ground everywhere was uniformly white, covered with hailstones on the open flat to a measured depth of one inch; the ground temperature amongst the ice was 33°F. In thirty minutes the ice was melting and water of 35°F. was pouring off the hills. At this time a very light drizzle commenced, continuing until 3:05 P. M. when the air temperature had fallen to 45°F. The heavy ground cover of tall grasses held the hailstones to a depth of from two to three inches. Not one grasshopper could be found anywhere, even on the flats or short grass.

One of my field stations lay 600 yards to the left, out of the path of the storm. Here, ground cover consisting of short cropped grasses was scarcely damp and third, fourth, and fifth instar nymphs and adults of *M. m. mexicanus* (Saus.) and adult *Amphitornus coloradensis ornatus* (Heb.) were hopping freely; the ground temperature was 63°F. and the air 61°F. Not a grasshopper was injured even by an occasional hailstone and leaf hoppers, terrestrial Hemiptera, mosquitoes and other Diptera were all very active.

The volume of hail that fell in twenty minutes, as registered by the rain gauge, amounted to .751 inches. Its fall was heavy enough to shatter the leaves of aspen and dandelion and to knock down immense numbers of fir needles. In the area of long grass and weeds and in places throughout the timber, the ice lay for many hours so that handfuls of it could be picked up twenty-two hours after the storm. Notwithstanding the mechanical damage done by the storm, the weight of stones that fell, the length of time the ice lay in all areas of long grass, and the sustained reduction in air temperature over the area of precipitation, grasshoppers of both species appeared when the weather warmed up and in time completed their development. From these two records it would appear that hailstorms, which occur in British Columbia in July, do little or no damage to grasshoppers, even those in the third, fourth, and fifth instars.

From reports received from prairie men, it would appear that Saskatchewan, from the middle of the province southwards to the international boundary, would be an ideal location for observing the effect of severe hailstorms on animal life. Violent storms occur somewhere throughout this area every year, with hailstones of immense size; those only 1 cm. long seldom do more than 50 to 60 per cent crop damage, but larger stones one inch and over in diameter, especially lenticular ones, produce 80 to 100 per cent destruction of all crops, besides killing all ground insects, field mice, much poultry and even producing great weals on livestock. The paths of the storms vary from a quarter mile to four miles in width and extend in interrupted strips from eighteen to two hundred miles in length, generally following the courses of dried river beds or valleys and depressions running west to east. While all insect life on the ground, including grasshoppers, is wiped out completely, the devastated areas are soon invaded by grasshoppers from the sides, and the strip action of the storms tend to limit and localize their value from the standpoint of control of these insects. The wholesale destruction of crops produces greater loss than is caused by the hordes of grasshoppers.

Acknowledgement. These records were made during the course of an investigation conducted for the Division of Entomology, Department of Agriculture, Ottawa. I am indebted to Dr. A. Gibson, Dominion Entomologist, for permission to use them.

EGG DEPOSITS OF A TYPE NOT USUALLY PRODUCED BY *MELANOPHUS MEXICANUS MEXICANUS* (SAUSS.) IN MANITOBA*

BY R. H. HANDFORD,

Dominion Entomological Laboratory, Brandon, Manitoba

In Manitoba *Melanophus mexicanus mexicanus* (Sauss.) is usually most abundant in areas of light soil. In such areas the bulk of the eggs are, as a rule, widely distributed in either cropped or recently reverted fields. Concentrations of eggs, when they occur, have commonly been confined to ridges of drift soil. During the fall of 1938, however, some of the heaviest concentrations of this species ever recorded for the province were discovered, not in these locations, but in woodland pastures of heavier soils in and near that portion of Lang's Valley occupied by the Pembina River. The oviposition sites, in fact, were so atypical that they resembled egg beds of *Camnula pellucida* Scud. rather than deposits of *mexicanus* eggs.

The Pembina River takes its rise in the Turtle Mountains of southwestern Manitoba, flows into Lang's Valley just south of Pelican Lake, broadens into Rock Lake and Swan Lake, cuts through the Pembina "Mountains" and continues to the Red River after crossing the international boundary six miles east of Windygates. The Manitoban soils through which it passes are medium to heavy clay loams on boulder till. From Rock Lake eastward the valley deepens rapidly until it is about three miles wide and 300 to 450 feet deep between the villages of La Riviere and Windygates. It was in and near this deeper portion that *mexicanus* concentrated.

Migrations from the Dakotas began about August 3. By the time the general adult survey was made, August 9 to 20, the areas in the valley and south of the valley were all severely and uniformly infested. A later investigation, September 6, indicated a decrease south of the valley but a decided increase in the valley proper. The drift had also increased the population north of the valley from fifteen to forty per square yard, but the tendency of the hoppers seemed to be to remain in the valley itself:

This tendency for migrations to be halted over deep valleys is apparently not unusual, but heavy concentrations of *mexicanus* eggs in such locations have not been previously recorded for Manitoba. The highest egg counts obtained were fifty-two pods for a full square foot sample and forty-two pods in a sample of thirty-six square inches. Most of these evidently survived, with the result that in June of 1939 most small grassy clearings in woodland pastures yielded large numbers of nymphs. Frequently over 1,000 per square foot were present at one time in spite of the delayed hatch. The higher counts were obtained in tiny plots of grass measuring from two square feet to about two square yards, and even in larger clearings there was a tendency for females to concentrate their eggs in restricted spots much as does *Camnula pellucida* Scud. The net result was that, delayed hatch and frequent showers notwithstanding, damage in June of 1939 was severe. In a small area near Snowflake several farmers lost their entire crop.

Why a concentration of *mexicanus* should have occurred under such unusual conditions is difficult to explain, particularly so since previous heavy immigrations of the species had not concentrated for oviposition in this particular type of location. One possible explanation lies in the fact that the autumn was extremely dry. (September was the driest monthly period ever recorded for the province.) Even soil in soddy spots was more or less "mulched" on the surface. Temperatures also were well above normal throughout the entire autumn and undoubtedly prolonged the period of oviposition. Moreover, the combination of heat, drouth, and early ravenous feeding of the immigrant swarms rapidly depleted the small amount of green vegetation that had survived in the open prairie, and though green growth was sparse in the wooded regions also, there was just enough more that it may have been another contributing factor in holding the grasshoppers in that location.

*Contribution No. 2058, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

A NOTE ON THE EFFECT OF CERTAIN FOODS UPON FECUNDITY
AND LONGEVITY IN *MICROCRYPTUS BASIZONIUS* GRAV.
(HYMENOPTERA) *

BY L. R. FINLAYSON AND THELMA GREEN,
Dominion Parasite Laboratory, Belleville, Ontario

In April, 1939, a trial was made of feeding the honey-sugar-agar mixture, formula 3**, devised by Holloway (1939) for feeding adult parasitic insects. The test was made with the laboratory propagated *Microcryptus basizonius* Grav., a parasite of conifer-feeding sawflies. The routine food used in this work is seeded raisin, in addition to water, as reported by Green (1938). An initial investigation indicated that the parasites preferred the prepared food to raisin and that they devoured it avidly. The prepared food was subsequently substituted for raisin in the regular propagation boxes, but after a few days the number of eggs laid was reduced to about ten per cent of the number expected. When the prepared food was removed and replaced by the raisin, the egg-laying rose abruptly to normal level.

However, it so happened that the number of parent females per cage was increased from five to ten about the time of the change in food. It was, there-

TABLE 1.

Time in Days from Beginning of Experiment	Oviposition by <i>Microcryptus basizonius</i> Grav. Number of Eggs Laid			
	With Raisin.		With Holloway's Food	
	Cages 1, 2, and 3	Cages 4, 5, and 6	Cages 7, 8, and 9	Cages 10, 11, and 12
2	63	115	52	103
4	93	175	75	160
6	99	200	87	160
8	93	129	65	148
10	73	123	51	82
12	73	144	18	35
14	58	94	4	10
16	51	110	11	21
18	34	96	1	5
20	46	84	5	3
22	31	72	4	3
Totals	714	1,342	373	730

fore, necessary to carry out an experiment to determine whether or not the increased number of females, or the food, or a combination of both was responsible for the decrease in oviposition. At the same time, the new experiment was planned to show if the effect was to decrease the rate of oviposition or to decrease fecundity. Twelve cages were arranged in the following groups:

- Nos. 1, 2, and 3. Five females each, raisin.
4, 5, and 6. Ten females each, raisin.
7, 8, and 9. Five females each, Holloway's food.
10, 11 and 12. Ten females each, Holloway's food.

The results are tabulated in Table 1.

The data secured eliminated the density of females per cage as a factor in the decrease, as approximately twice the number of eggs were obtained in each case when ten females were used instead of five. They also show that the effect of the prepared food is to greatly decrease the fecundity of *Microcryptus*. The experiment was terminated when the females in the series with prepared food were all dead, but, due to their greater longevity, the females in the series fed with raisin would probably have produced a considerable number of eggs over and above the totals tabulated. It seems safe to say, therefore, that there was

*Contribution No. 2021, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

**1% agar solution 50 cc.; honey 25 cc.; granulated sugar 25 g.

a reduction in fecundity of at least 50 per cent in those boxes with prepared food, as compared with those supplied with raisin.

TABLE 2.

Oviposition by *Microcryptus basizonius* Grav.

Time in Days from Beginning of Experiment	Number of Eggs Laid	
	With Raisin Cages 1, 2, and 3	With Holloway Food Cages 4, 5, and 6
2	53	53
4	128	117
6	134	111
8	189	88
10	145	32
12	142	3
14	128	5
16	95	1
18	80	0
20	74	1
22	65	2
24	40	0
26	35	0
28	27	0
30	30	1
32	12	*
34	12	
36	15	
38	10	
40	8	
Total	1422	414

TABLE 3.

Oviposition by *Microcryptus basizonius* Grav.

Time in Days from Beginning of Experiment	Number of Eggs Laid	
	With Raisin	With no Food
2	36	32
4	49	43
6	86	36
8	61	20
10	63	3
12	57	0
14	54	*
16	46	
18	40	
20	20	
22	28	
24	28	
26	23	
28	14	
30	11	
Total	616	134

A further experiment, in verification of the above results, was carried out with six cages of ten females each, three with prepared food, and three with raisin. The data are given in Table 2. Condensation of results in both Tables 1 and 2 hides the substantiating fact that individual cages in any one series yielded very similar results. The results of this experiment justify the conclusion drawn from the first experiment. The experiment was terminated before all females in cages 1, 2, and 3, were dead.

*Females all dead.

To determine the effect of raisin only on fecundity and longevity, a group totalling ten females was fed raisin and water, and a group of equal size supplied with water only. Table 3 shows the number of eggs obtained, and the early mortality of those without raisin.

It would seem from the foregoing evidence that certain foods may have a very marked effect on both the longevity and fecundity of *Microcryptus basizonius* Grav. adults, and that of the two foods tested, raisin is preferable in respect to its effect both on longevity and fecundity.

LITERATURE CITED

- Holloway, J. K. 1939. An agar preparation for feeding adult parasite insects. Jour. Econ. Ent. 32:154.
Green, T. U. 1938. A laboratory method for the propagation of *Microcryptus basizonius* Grav. 69th Ann. Rep. Ent. Soc. Ont. 32:34.

A METHOD OF MOUNTING SMALL BEETLE GENITALIA

BY GEORGE R. SWANK,

Iowa State College, Ames, Iowa.

While studying some of the smaller coccinellid beetles a method of mounting the genitalia has been developed which can probably be applied to many other groups with slight modifications.

Wilson (1930) has given a somewhat similar method for removing the genitalia from the beetle without the complete destruction of the specimen and mounting them in cardboard rectangles. Eltringham (1930) has detailed a method for mounting the genital armature between two cover slips which could be more conveniently stored than microscope slides. McKenzie (1936) used shellac to fasten the part to a piece of cardboard which was mounted on the pin with the specimen. The result of an effort to combine these three techniques and adapt them to a particular problem are recorded in this paper.

The problem has been to remove the genital tube from the male coccinellid and still have the specimen sufficiently intact to be mounted for further study; to preserve the excised genitalia for future reference or study either by reflected or transmitted light; and to keep the genitalia and beetle together in order to avoid their complete separation necessitating an indexing or cataloging system. This has been done by the preparation of a cell for the aedeagus which could be mounted on the same pin with the pointed specimen and any other pertinent information as shown in figure 1.

The cells were made from a good grade of compact cardboard, white on both sides, and about 0.5 millimeter thick. The cell in which the mount was placed was made by using a card punch making a one-eighth inch round hole. This hole was exactly in the centre of a one-fourth inch disc on the end of a tapering stem. The disc with the attached stem was made as follows: A wedge was placed between the jaws of the larger punch and adjusted so that the disc was cut only one half of the way around its circumference. The ends of this semicircular cut were then continued on tangential lines to a point five-eighths of an inch from the centre of the disc. When one-eighth inch of the apex was cut off, a cell with a stem as shown in the accompanying figure was produced.

Cover slips were made by punching discs with the larger punch from a clear grade of thick cellophane. Photographic film from which the emulsion had been removed was found satisfactory. Just enough canada balsam was placed on one side of the disc to completely cover the ring when the cover slip was pressed in place. These cells with one cover slip in place were placed under pressure until the canada balsam had hardened and were then stored until needed.

Removal of parts from small specimens requires special tools and some patience. The suggestion of Britton in his chapter in Eltringham's (1930) book was followed in making and sharpening small instruments. This was done by pressing pin points or other bits of fine wire into the end of a match stem and shaping the projecting end as desired. These instruments were kept sharp by placing on a piece of glass and rubbing with a blunt instrument or shaving them with an old scalpel. The following were found useful and each worker may make additional kinds as the particular need arises.

One or two pairs of dissecting needles were made of "minuten madeln" or very fine insect pins with selected fine points. Blunt ends, sharp ends and hooked ends have all been found useful. Small loops made from very fine wire, similar to those used in making bacteriological inoculations, were used very frequently in the transfer of parts or small quantities of liquid. Several small knives of varying shape were made. Although the flattened, sharpened end of very fine wire served the purpose the hairspring of an old "Ingersoll" watch was particularly good. A couple tiny spatulas and a pair of tweezers with the points ground fine for use with larger specimens were included in the kit. In order to aid in the selection of a particular instrument in a hurry the handles (match



Fig. 1. Method of mounting small beetle genitalia.

stems) of each type were made a different color by rubbing them with a wax pencil; i.e., needles blue, knives red, hooks green, etc.

Since the male genital tube of the coccinellid shows a greater variation than the female and was most generally used, the following procedure applies most particularly to the male. Freshly killed specimens, specimens preserved in alcohol and formalin, and completely dried specimens were used in making mounts. Since the dry material requires the most care the handling of this type of material will be described in detail. The other kinds of material were handled in the same way after dissection and cleaning were complete.

A few specimens were placed in warm water until they became completely relaxed. If the parts were very hard a 10% solution of potassium hydroxide hastened relaxation. The dissection was done on a block of balsa wood under a dissecting microscope. The elytra were spread apart and an incision made in the underlying membranous tergum. By passing a knife or tiny spatula carefully under and around the aedeagus it could be lifted out from the left side of the abdomen with the adhering abdominal contents. The excised genitalia were at once placed in a drop of 10% potassium hydroxide solution on one end of a microscope slide where they were allowed to remain and kept warm until the adhering materials softened enough to be removed.

While the aedeagus was soaking and before the beetle had become dry, it was thoroughly washed with water to remove the caustic solution and then transferred to a blotter to remove the excess water. Before it was too dry, the wing covers and other parts were arranged in the position desired in the mounted specimen. As soon as the specimen was dry enough it was mounted and set to one side until the completed cell was ready.

After soaking for some time in the caustic solution, the genital apparatus was cleaned of all extraneous material. The part was then washed free of caustic and placed in a drop of beachwood creosote. Just enough balsam was placed in a cell and on the disc to form a slightly convex surface. The genitalia were then transferred from the creosote to a drop of xylol, then to the surface of the balsam. It was soon learned that the surface of the balsam should never be touched without first applying a loop of xylol to it. By keeping the surface and instruments moist with xylol the parts were oriented and bubbles removed from the cell. The cover slip was pressed into place and the excess balsam used to seal the edges against the entrance of bubbles during drying.

Cells with the aedoeagus in place were now placed on the same pin with the insect and stored in a horizontal position until the balsam had hardened. Specimens mounted almost a year ago still show no deterioration.

Although the procedure as described may seem involved, when once the routine was learned specimens were handled rather rapidly. The cleaning process required the most time but with proper macerating this step was considerably shortened. However if they were allowed to remain too long in the caustic solution the parts became limp and tended to bend and collapse. By mounting the beetle while the part was mascerating, the procedure was about as economical of time as it would have been to run more than one specimen, and the danger of getting the parts confused was eliminated.

I wish to acknowledge the help received from Dr. E. R. Becker of the Zoology Dept. of Iowa State College for advice and suggestions in the materials and technique and to Dr. H. H. Knight also of the Zoology Dept. of Iowa State College for suggestions and encouragement.

LITERATURE CITED

- Eltringham, H. 1930. Histological and illustrative methods for entomologists. Clarendon Press. Oxford. pp. 140.
McKenzie, H. L. 1936. An anatomical and systematic study of the genus *Anatis* (Coloep-Coccin.) U. of Calif. Pub. in Ent. 6:263-72.
Wilson, J. W. 1930. The genitalia and wing venation of the Cucujidae and related families. Ann. Ent. Soc. Amer. 23:305-358.

A NOTE ON THE BIOLOGY OF *POLISTIPHAGA ARVALIS* CRESSON (HYMENOPTERA, ICHNEOMONIDAE)

BY A. T. GAUL,

Brooklyn, New York.

In the course of collecting several nests of *Polistes fuscatus* Fabricius and *P. fuscatus* var. *pallipes* Lepageletier (Hymenoptera, Vespidae), six were found to be highly parasitised by *Polistiphaga arvalis* Cresson. The female *Polistiphaga* normally deposits from two to six eggs either on the *Polistes* larva or in the cell with the larva (oviposition has not been observed). She selects the larvae that are nearly ready to pupate, with the result that pupation occurs before the parasitic larvae that develop make any considerable inroads into the tissues of the host. Thus the larvae that consume the *Polistes* pupa live under the protection of the host's silk pupa cap. Instances are not uncommon in which the parasitised host larva fails to pupate; this condition seems not to effect the life of the *Polistiphaga* larvae.

One singular instance was noted in which thirteen *Polistiphaga* pupae had developed in a single *Polistes* cell; all were unusually small and none lived to become adults. Perhaps two females had oviposited in the same cell, thus doubling the normal number of parasites.

The parasitized cells are distributed irregularly throughout the *Polistes* nests. The *Polistiphaga* larvae are free living ectoparasites and are capable of locomotion anywhere within the cell of their individual host. They cannot

penetrate through the paper or silk cap of the cell. When the aperture of the cell is open (through failure of the *Polistes* to pupate, or if opened for observation) the larvae do not crawl about the nest but remain with the original host. These larvae exhibit a preference for the abdomen of the host pupa. It is likely that they prefer the softer non-chitinated tissues for easier feeding; and as the abdomen is slower to become chitinous, it provides the best source of food. In the cells containing two to four *Polistiphaga* larvae, the host abdomen is reduced to a thread of stringy tissue. If the cells contain five or six larvae, the *Polistes* may be reduced to a part of the head, all the other tissues being consumed. In no case, however, was all the host pupa consumed. In the instances in which the *Polistes* larvae failed to pupate, no parts of the host remained, either because of complete consumption, or because the uneaten parts fell from the nest.

After partaking of as much of the host's tissue as it requires, the larval *Polistiphaga* retreats to the base of the cell (where there is plenty of room due to the decimation of the host abdomen) where it spins its cocoon. The cocoon is a very thin, transparent silk envelope attached to two adjacent sides of the hexagonal paper wall of the cell; the third side is more durable in construction and is exposed to the lumen of the cell. This exposed face of the cocoon varies from white to yellow-red; the anterior portion is of a peculiar cork-like consistency.

If two, three, or four parasites inhabit one cell, they may all find room at the base of the cell in which to construct their cocoons. If more than four *Polistiphaga* live in a single cell, those which pupate last find no room at the base of the cell, so they superimpose their cocoons upon the earlier arrivals.

The *Polistiphaga* pupae orient themselves in the normal inverted position of the host, i.e., with the head toward the aperture of the cell. A single case must be remarked in which a male pupa was found facing the base of the cell, although all the others in the same cell were in normal alignment. After making an aperture in its cocoon through which it will eventually emerge, the young parasite cautiously views the world from its safe position. If any object looms into view, an adult *Polistes*, etc., the *Polistiphaga* will hurriedly retreat to the depths of its cocoon. Once away from the nest, however, the creature exhibits considerable boldness and will even stroll on one's hand. Emergence from the cocoon may be accomplished in one of two ways. Either the young *Polistiphaga* may tears its way into the lumen of an adjacent vacant cell; or, as is more usual, it may cut through its own cocoon. An instance was noted in which a mature adult, whose cocoon was at the base of the cell, could not emerge until after the emergence of the individual in the cocoon above. Emergence may occur at any hour of the day or night.

As soon as the adult has emerged it is capable of full flight and does not have to wait, as does its host, for wings to stiffen. During the first flight it releases a white drop of excretory material. In a parasitized cell, the individuals may or may not be all of the same sex. In a nest of 193 cells, one parasitized cell yielded three females and two males, an adjacent cell yielded four females. The adult *Polistes* exhibit no inimical attitude toward the *Polistiphaga*. Indeed, in the breeding cage the two species take no cognizance of each other. The ichneumon generally avoids trespassing upon the *Polistes* nest except of necessity to oviposit.

In one breeding cage no provision was made to feed the adult *Polistes*. These soon became cannibal and ate their brood. In this same cage all the *Polistiphaga* cocoons were opened for observation, and the pupae were available to the hungry *Polistes*, but they were not molested. A female *Polistes* who was purposefully starved for twenty-four hours finally did accept a *Polistiphaga* pupa that was offered her. In none of the breeding cages did reinfection occur although both sexes of the parasite and ample *Polistes* brood were present. Either the *Polistiphaga* did not mate in the more or less confined space of the cages, or the females of the fall brood would not oviposit until the next season.

Although the author has no definite proof, it seems likely that adult *Polistiphaga* may pass the winters in hibernation. Several females were placed in a vial and put in the ice tray of a mechanical refrigerator. Temperatures in this tray fell as low as -8 degrees centigrade. Upon a regular twelve hour schedule of alternate freezing and thawing, these females lived from 19 to 23 days (even then death may have been due to starvation or thirst and not the cold). During each freezing period the creatures would assume a characteristic 'hibernation' pose; wings flat over the back, antennae extended straight, fore and mid legs retracted close to the body, and hind wings slightly extended for support. A further indication that adult hibernation is customary is that all the parasitic pupae emerged in August and September; this fact also increases the likelihood of there being two broods each year, one in the late spring and another in the early fall.

One *Polistiphaga*-infected nest was taken at Hartsdale, N. Y., on July 26, 1940. Eleven nests were taken at Port Murray, N. J., on August 5 and 23, 1940; five of these were infected. The infected nests taken on August 23 already had empty *Polistiphaga* cocoons; the adults emerged in captivity from that date until September 6. The adult *Polistiphaga* emerged from the Hartsdale nest on August 11. The last adult *Polistes* emerged on September 2. Nests from Amityville, N. Y., and Salisbury, Conn., accommodated no *Polistiphaga aravalis*.

The six parasitized nests aggregated 459 brood cells of which 51 or 9 per cent. contained *Polistiphaga*. As the *Polistes* colonies were in various stages of decadence, the brood cells were not all occupied; the percentage of parasitized cells among the existing brood was 35 per cent. The population of the 51 parasitized cells was over 127 (some had emerged previous to the collection of the nests). Eighty-seven *Polistiphaga* adults emerged; 40 pupae did not live to emerge; all the larvae pupated. A plurality of the parasitized cells contained four *Polistiphaga*. The sex ratio was four females to five males. These figures are interesting, but they are far too inadequate to draw any valid conclusions.

On August 27, one of the parasitized cells was opened to observe the stage of development of the *Polistiphaga* pupae. This cell accommodated four *Polistiphaga* cocoons. The first cocoon contained 13 pupae of a chalcoid, *Dibrachys cavus* Walker (Gahan) evidently parasitic upon *Polistiphaga*. No part of the original *Polistiphaga* was left in this cocoon. The *Dibrachys* pupae were all in the same stage of development, and all became adult on September 5 and 6. The second cocoon contained a mature male *Polistiphaga* which was dead and desiccated. The third cocoon contained a pupa of *Polistiphaga* about half matured; in the cocoon with it were six small larvae, probably the larvae of the same chalcoid. One of these was firmly attached to the ventral surface of the pupa; the others were crawling about freely. The fourth cocoon was empty, and it was impossible to determine whether an adult *Polistiphaga* or the *Dibrachys* parasites had emerged. With the 13 chalcoids in the first cocoon, there emerged a single specimen of *Pteromalus puparum* Linn., which was evidently a parasite of the larger *Dibrachys cavus*. This individual emerged from a pupa of *Dibrachys* on September 7. So here we see an example of tertiary parasitism on *Polistes*; *Pteromalus puparum* on *Dibrachys cavus*, *Dibrachys* on *Polistiphaga aravalis*, and *Polistiphaga* on *Polistes*.

CORRECTION OF A MISUSED GENERIC NAME (LEPIDOPTERA, OLETHREUTIDAE)

BY CARL HEINRICH,

Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

In my revision of the North American Eucosminae (Bull. 123. U. S. Nat. Museum, p. 172, 1923) I applied the generic name *Exentera* Grote to a small group of closely related species including *improbana* Walker (= *cresson-*

iana Clemens) and *spoliata* Clemens. I did this upon the assumption that, in the main, Fernald and others had correctly identified the Grote species. Although I had gone over the Fernald collection at Amherst, Mass., I did not see the Grote types, and assumed that they were in the British Museum and so stated in the revision (p. 174). However, after the Fernald collection came to the National Museum the types of *apriliana* (or rather what remained of them) were found. They consist of a pair of male fore wings glued to a card and labeled "*Exentera apriliana* Grote ♂ type", a female left fore wing similarly mounted and bearing two labels, a W. W. Hill collector label with the date "IV-23-77" and a name label, "*Exentera apriliana* Grote ♀ type". The name labels are both in Grote's handwriting. On a third card are a denuded left fore and a denuded left hind wing (both female) and labeled "*Exentera apriliana* Grote ♀." The handwriting appears to be Grote's and the wings are presumably fragments of the ♀ cotype. The denuded fore wings are as Grote described them: "concolorous, dark olivaceous fuscous, a little mottled..... under the glass..... seem to be covered with whitish-tipped fuscous scales." They represent a typical species of *Eucosma* with a long costal fold on the male fore wing and close to but apparently distinct from *Eucosma landana* Kearfott. The name *Exentera* Grote therefore falls as a synonym of *Eucosma* Hübner and a new name must be given for the genus which I treated under the Grote name. I am proposing the following:

Pseudexentera new genus

Exentera Heinrich (not Grote), Bull. 123, U. S. Nat. Mus., pp. 172, 173, 1923.

Genotype. (*Hedya cressoniana* Clemens) = *Siaphila improbana* Walker.

Grote's species must be removed from the synonymy of *improbana* Walker and recognized as a valid species under the new combination *Eucosma apriliana* (Grote). According to the present arrangement it would be listed between *nandana* Kearfott and *landana* Kearfott. Incidentally, Grote is in error in stating that his species has only seven veins in the hind wing. All eight veins are present as in normal *Eucosma*.

A NEW PSEUDEXENTERA FROM HICKORY (EUCOSMIDAE, LEPID.) *

BY J. McDUNNOUGH,
Ottawa, Ont.

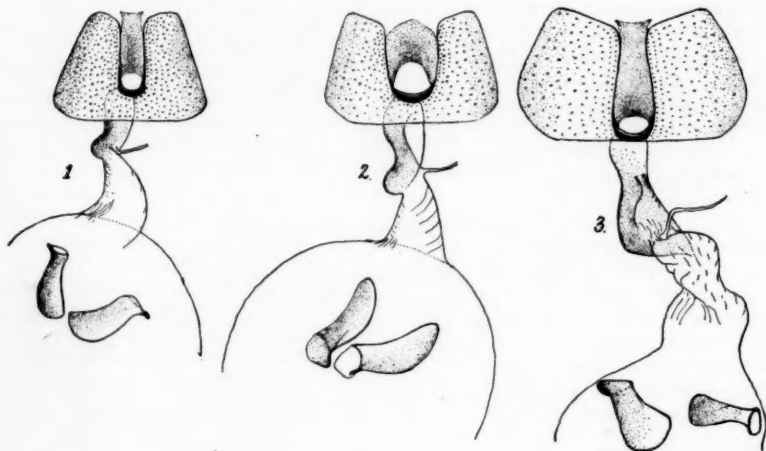
When checking over recently our species of the Eucosmid genus heretofore known as *Exentera* Grt. but which must now be called *Pseudexentera* Heinr., I came across two females, bred from *Carya ovata* by our field officer, Mr. W. L. Putman, which on genitalic characters appeared to belong to an undescribed species. On submitting them to Mr. C. Heinrich of the United States National Museum he agreed that the species was new and was able to locate in the Barnes Collection a small series of similar specimens which had originally been collected by myself flying around hickory trees on the Decatur Country Club grounds at a period when I was curator of the Barnes Collection. These he has kindly forwarded to me with the request that I describe the species.

Pseudexentera caryana n. sp.

Female. Palpi, head, thorax and forewings deep leaden-gray, the outer section of the latter beyond the basal patch sprinkled with white scales. The usual outwardly angled basal patch is darker than the balance of the wing, due primarily to the lack of white sprinkling; its oblique outer edge is well-defined on the inner half of wing but rather obscure in the costal half. The median area is considerably paler than the preceding one especially above inner margin,

*Contribution from the Division of Entomology (Systematic Entomology), Department of Agriculture, Ottawa.

where the white sprinkling is heaviest. There are traces of a large, irregularly quadrate, dark patch before anal angle. The costa beyond the basal patch shows numerous short dark streaks, interspersed with pale ones; two of these dark streaks are produced obliquely to connect obscurely with the tornal patch and others extend towards the ocellus; this is composed of two vertical metallic bars, somewhat convergent toward anal angle and the intervening dark area shows faint traces of three or four transverse black lines. Several short metallic streaks occur in the costal area above the ocellus and there is a small black spot at apex of wing. Fringes leaden, deeper in color at base and outwardly. Secondaries light smoky with paler fringes which show a dark basal line.



Female Genitalia of 1. *Pseudexentera improbana* Wlk.; 2. *P. oregonana* Wlshm.; 3. *P. caryana* n. sp. (Holotype).

Male. Apparently somewhat lighter in color than the female, but the specimens are rather rubbed and the details of maculation in consequence obscure. Expanse 18 mm.

Holotype—♀, St. David's, Ont., April 14, 1938, W. L. Putman; No. 5105 in the Canadian National Collection, Ottawa.

Allotype—♂, Decatur, Ill., April 24-30. In United States National Museum ex Coll. Barnes.

Paratypes—1 ♀, same data as Holotype; 1 ♀, A. & M. College, Miss., March 19, 1931, (R. E. Hutchins); both in the Canadian National Collection, Ottawa; 2 ♂, 6 ♀, same data as Allotype; 1 ♀, Cent. Mo., April 7, 1896; all but one pair in the United States National Museum.

The species is rather similar in indistinctness of maculation to the poplar-feeding *oregonana* Wlshm. which to my mind should, on female genitalic characters, be considered a good species and not a race of *improbana* Wlk. The most characteristic feature of the genitalia of the present species as compared with those of *improbana* and *oregonana*, is the position of the ostium which is on the cephalic margin of the genital plate and not considerably above it as in the other two species. Mr. Heinrich, who has made a slide of the male genitalia, states that the presence of an extra spine on the cucullus distinguishes the species from its allies.

THE VALUE OF HAND CONTROL FOR THE TENT CATERPILLARS,
MALACOSOMA AMERICANA FABR. AND *MALACOSOMA*
DISSTRIA HBN. (LASIOCAMPIDAE, LEPIDOPTERA)

BY HARVEY L. SWEETMAN*
Amherst, Massachusetts.

The eastern and forest tent caterpillars are native insects and have been recognized as pests of forest trees and shrubs since colonization of this country by the early settlers (Swaine, 1913; Baird, 1917; Baerg, 1935; Wadley, 1938). The eastern tent caterpillar becomes conspicuous in the spring about the time the leaves of wild cherry appear and thereafter for about a month. When the infestation is heavy the tents and defoliation can be seen wherever favored food plants are abundant, particularly wild cherries and unsprayed apple trees. The caterpillars and their unsightly tents are more annoying to most people than the damage to plants. The forest tent caterpillar does not build tents so is not so conspicuous unless sufficiently abundant to produce defoliation of its food plants. However, the larvae remain in colonies (Swaine, 1913) and frequently gather on the trunks of trees a few feet above the ground, particularly on hot days.

When the caterpillars of both species become nearly mature, they leave the colonies and wander about for a while before pupating, although some feeding still occurs. At such times when the caterpillars are numerous, particularly with the forest tent caterpillar, large numbers may collect on tree trunks, fences, walls of buildings, even in houses, and other places where shade or shelter exists.

Distribution. The eastern and forest tent caterpillars are native to the North American continent and are distributed over most of the United States and Canada where their food plants occur. They are most abundant in north-eastern United States and eastern Canada (Baird, 1917; Tomlinson, 1938; Wadley, 1938).

Life History. The winter is passed in the egg stage. In New England the eggs are laid mostly in July and early August. Embryonic development is concluded in about a month, but hatching of the eggs is delayed until the following April or early May. The larval stage lasts from four to eight weeks and the pupal stage from three to five weeks, depending upon the temperature. Soon after emergence of the adults, mating and oviposition occur. The next season's brood will develop from these eggs.

Cycles. The abundance of both species is noticeably cyclic in occurrence. The peak of abundance occurs approximately every nine to twelve years, the pests being abundant for two to four years, then gradually become less and less numerous for a like period when the population again increases (Baird, 1917; Headlee, 1934; Lutz, 1936; Tomlinson, 1938). Entomologists have frequently attributed the cyclic development to insect parasites and predaceous enemies (Britton, 1935; *et al*). However, data to support these contentions are not available. Our studies, still incomplete, suggest that a wilt disease produced by a virus combined with unfavorable spring weather may be major factors in reducing abundance cycles (Fiske, 1903; Tomlinson, 1938; Wadley, 1938). Later, starvation, produced by defoliation of the host plants, which is common on peak years of abundance, seems to be conducive to epidemics of disease.

Control. The pupal and adult periods are the shortest stages in the life cycle and do not allow much time for artificial control attempts. The pupae are widely scattered, usually well hidden, and protected in thick cocoons. The adults mate and reproduce shortly after emergence. The pests are open to attack for control in the egg and larval stages. The egg stage lasts from nine to ten months and the larval period from four to eight weeks. The methods of control for

*Contribution from the entomological laboratory of Massachusetts State College, Amherst, Massachusetts.

these pests that have gained prominence are biological, chemical, ecological, and mechanical.

Biological control. A number of insect parasites and predators, a few birds, and one or more diseases are known to attack the pests. (Williams, 1916; Tothill, 1923; Britton, 1935; Lutz, 1936; Sweetman, 1936; Wadley, 1938; Hodson, 1939). Egg parasites are very common and usually a few eggs in each egg mass are parasitized. However, reports of percentages of parasitism of the eggs in Massachusetts (Williams, 1916; Tomlinson, 1938), Vermont and New Hampshire (Tomlinson, 1938), New York (Lutz, 1936), and in Minnesota (Hodson, 1939) are low. Collections of egg masses made during an outbreak by Bourne (Mass. Agr. Exp. Sta.) for three successive years showed a parasitism of 5, 12, and 17 per cent respectively. Not all of these egg parasites are adapted in their life cycles to those of the tent caterpillars, but emerge the same season that they are laid and in turn attack other hosts. Tomlinson (1938) found little evidence of predatism on eggs by birds or other animals during the winter months.

Since an egg mass ordinarily may contain from 150 to 350 eggs, it can be seen that about one per cent of the offspring of the moths of any one season must survive to replace the parent population. Campaigns for destruction of egg masses have been condemned as doing more harm than good as they tend to disturb the natural balance in nature (Lutz, 1936). Considering the low percentage of egg parasitism that prevails, it would seem that this condemnation is unfounded unless the egg stage plays an important role in transmission of the virus disease. It is unknown at the present time how this disease is transmitted from one generation to the next.

Our work as well as that of others shows that the great loss in population occurs during the larval period, or with pupae that were attacked during the larval period. A large number are destroyed by insect parasites, yet large percentages of parasitism are seldom, if ever, recorded. Schaffner and Griswold (1934) report a parasitism of about four per cent of over 60,000 larvae and pupae of the eastern tent caterpillar collected over 15 years. Figures for the same period for the forest tent caterpillar were about 19 per cent parasitism of over 18,000 larvae and pupae. The deaths from diseases are not included in the above figures. Fiske (1903) after studying the influence of parasites on populations of the eastern tent caterpillar for several years estimated that 15 to 20 per cent of the larvae and pupae were destroyed annually by insect parasites. The ineffectiveness of the parasites was attributed largely to hyperparasitism. Other workers (Lowe, 1898; Britton, 1935) report higher percentages of parasitism from occasional collections of caterpillars and pupae. Such occasional collections, however, are not sufficient to be considered significant.

The investigations of other workers as well as our own suggest that the virus "wilt" is a major factor in control (Chapman and Glaser, 1915; Lutz, 1936). The contention of Lutz that control of the eastern tent caterpillar should not be attempted except on orchards and ornamentals because the balance of nature will be disturbed ignores the fact that both the eastern and forest tent caterpillars can be controlled economically and successfully over considerable areas. Certainly the beautiful bloom of wild cherry year after year is much superior to periodic ugliness of tents and defoliated trees.

Chemical Control. The pests can be controlled in the larval stage with arsenate of lead, two or three pounds to a hundred gallons of water. The addition of three pounds of hydrated lime will aid in preventing foliage injury, and one and one-half pints of linseed or fish oil will assist considerably as an adhesive for the poison (Wadley, 1938). The spray should be applied when the caterpillars are young and before serious defoliation of the plants occurs. Both species of tent caterpillars often oviposit on fruit trees but never become a serious

pest on a well-sprayed orchard. The usual arsenical applications essential for control of other insect pests are more than adequate for control of tent caterpillars. Certain types of fruit, as prunes and peaches, that are not sprayed regularly with arsenicals may suffer from tent caterpillar attacks (Urbahns, 1930). Where regular applications of arsenicals are the practice, no other control need be considered, but about the home, pasture, roadsides, woodlot, and other places, it may not be economically feasible or desirable to apply poison sprays. In such cases hand methods may prove much more economical and equally efficient to poison sprays.

Mechanical Control. The common hand methods consist of collection and destruction of the eggs and larvae. The collection and destruction of egg masses has received much publicity, far more than warranted by the effectiveness in control obtained. Boy Scouts, 4-H clubs, and similar organizations have put forth extensive local campaigns, and large numbers of egg masses have been collected and destroyed. Little information is available on the effectiveness of such campaigns, since they have not been conducted on a scientific or well-controlled basis. The effectiveness is undoubtedly greatly overrated. Following such campaigns, surprise is often expressed at the number of tents or at the defoliation that may appear the following spring over the same area shortly after the eggs begin to hatch. This is not necessarily because of carelessness on the part of the collectors, but because of the difficulty in observing a high percentage of the egg masses. During the winter of 1936 and 1937, the writer attempted to eradicate tent caterpillars over about a quarter of an acre of brush containing much wild cherry, mostly less than twelve feet high. Much to his amazement in the spring, about 20 per cent of the egg masses had been overlooked. This resulted following several searches over the area for eggs. One of my colleagues (Bourne, Mass. Agr. Exp. Sta.) reports a similar experience. He and another entomologist set about to collect 500 egg masses along a railroad right of way. Egg masses were fairly numerous and the desired quota was collected along about a half mile of the right of way. The following spring he was amazed at the number of tents that appeared along the right of way where they supposed a very high percentage of the egg masses had been collected. These examples serve to emphasize the difficulty trained workers have in finding the eggs and explain why untrained workers miss so many of the egg masses.

Unless egg-destroying campaigns are followed by larval campaigns, the larvae from missed egg masses are almost certain to find an ample food supply and are much less subject to attacks of epidemic disease. Therefore they are much more likely to survive, because of the more favorable environmental conditions. The same amount of energy expended in the spring in destroying the larvae as explained later would be far more effective and conservative of the energy and time expended. Many of the eggs will survive if dropped on the ground so the masses should be destroyed following collection.

Destruction of the larvae is much simpler and much more effective than destruction of the eggs. It is much simpler to do this shortly after the larvae hatch. This eliminates most of the damage and destroys the tents of the eastern tent caterpillar before they become large enough to become unsightly. At this time the tents are very conspicuous and easily seen (Wadley, 1938). The writer has practiced hand control over an area of a little over two acres since 1937 with success. This method was undertaken after abandonment of the collection of egg masses described previously. This area is partially isolated from favored food plants on three sides for a distance of 100 to 200 yards, with an apple orchard on the remaining side. It was cut-over wood and pasture land preceding the control work and abounds with wild cherries (*Prunus serotina*, *P. virginiana*, *P. avium*, and *P. pennsylvanica*). Over a dozen species of various forest trees

including the favored species of the forest tent caterpillar are on the plot also. The eastern tent caterpillar was very numerous on the plot in 1936, but the forest tent caterpillar was relatively scarce. The control work was started in 1937. Most of the tents were less than 10 to 12 feet above the ground, although taller wild cherries were available. The caterpillars in the low tents were destroyed by rolling them between the palms of the hands. Cotton flannel gloves were used to protect the hands. When the tents are small they can be rolled and removed with one or two strokes of the hands. A glance to detect and destroy any scattered larvae that may have been out feeding permanently removes the colony. Destruction of the tents should be done when the larvae are clustered in them rather than when out feeding. This occurs on cold days, in the early morning, on cool evenings, and at certain hours of the day following feeding. The missing of an occasional larva, when small, is of no consequence, as such larvae seldom if ever survive. Occasional colonies that were too high to destroy by hand were removed with a pole with a few nails driven through the end from all sides. Two or three turns of the pole after the nail claws are placed against the tent are sufficient to remove it and practically all of the caterpillars. In no case did sufficient larvae remain to reconstruct the tents. The results of the past few seasons are as follows:

Year	Colonies destroyed
1936	None
1937	100 to 125
1938	6
1939	No control
1940	5

A few colonies of forest tent caterpillars were seen and destroyed in 1937 and 1938. These larvae do not build tents but remain in colonies for a portion of the larval period (Swaine, 1913). They congregate on hot days, particularly on the undersides of large branches or preferably on the main trunk of the trees near the ground. The only colonies observed were in the latter position. Rubbing the gloved hand over these colonies quickly destroyed them. No colonies of the forest tent caterpillar and no pupae of either species have been observed in 1940, thus indicating the effectiveness of the method. A total of not more than two 8-hour days has been spent in hunting and destroying the caterpillars. Thus hand destruction of the larvae in tents and colonies has proved much more economical and time-saving than collection of egg masses and at the same time has been effective. Applications of insecticides for control would not have been economically feasible.

Britton (1935) recommends a cone-shaped brush for removal of the high tents. He states the brush "was made for the purpose and worked admirably". The larvae could certainly be crushed and removed much more easily from the brush than is the case with the nail claws.

If allowed to develop, the tents become very unsightly and at such times torches are often used to destroy them. Torch burning is to be condemned. True, the tents are destroyed, but many larvae escape the fire unharmed and the tree may be seriously injured and is rendered more unsightly than if the tents remained. Frequently, the fire hazard from such torches is dangerous also. The large tents can be just as effectively eliminated by the gloved-hand and pole or brush methods as small tents.

Ecological Control. The role of environmental factors other than parasites, predators, and diseases is often overlooked. Probably both species of insects have increased in abundance and certainly in distribution with the advent of settlement of North America. This is because of clearing and destruction of

forest types that have been replaced partially at least by food plants favorable for development of these pests and the planting of suitable food plants in treeless areas (Lowe, 1898; Baird, 1917; Tothill, 1923).

Preliminary studies have shown that temperature conditions in the spring are critical in the welfare of the larvae. Once the caterpillars have hatched, cool weather may be very detrimental to them. Our studies indicate that early warm weather that induces hatching, followed by cool weather for a week or two, frequently destroys a high percentage of the larvae (Tomlinson, 1938). Tothill (1923) reported that a spring frost in New Brunswick killed so many young larvae of the forest tent caterpillar that the species was reduced to "extreme rarity". Blackman (1918) observed similar results in New York when "probably less than one per cent" survived a cool rainy spell following a week of warm weather in April that induced hatching. Wadley (1938) states that "sometimes unfavorable weather appears to be responsible for the sudden reduction of the pest to insignificant numbers." Lowe (1898) stated that a cold wind and rain would destroy large numbers of newly hatched larvae. Weed (Fiske, 1903) considered weather as probably the most important factor influencing fluctuations in abundance of the caterpillars.

While the evidence is not adequate for final conclusions it is felt that low spring temperatures following one or two weeks of weather favorable for hatching of the eggs is a frequent cause of failures of epidemics of caterpillars of both species.

SUMMARY OF CONTROL

Biological. The eggs are attacked by a number of insect parasites, but the percentage of parasitism remains low. Predators on the eggs are of no practical importance. Numerous caterpillars and pupae are destroyed by insect parasites and predators, birds, and a virus disease. The virus disease appears to be most important and frequently nearly wipes out heavy infestations but is of less value against light infestations. The insect and bird enemies are more important against light infestations, but never seem to bring epidemics under control.

Chemical. The pests are readily controlled by spraying with arsenate of lead, two to three pounds to a hundred gallons of water. It is seldom economically feasible or desirable to spray for tent caterpillar infestations alone.

Mechanical. Large numbers of eggs can be collected and destroyed during the winter months resulting in a considerable reduction in numbers of caterpillars. However, destruction is seldom complete enough to meet strict control requirements.

More effective control can be obtained by destroying the caterpillars. The eastern tent caterpillars are easily destroyed in the tents by rolling the tents close to the ground between the gloved hands and collection of the more elevated colonies with a brush or nail-claws on the end of a pole. The tents with the caterpillars are twisted onto the brush or nail-claws and then crushed. The caterpillars can be destroyed in any stage of development, but it is preferable to destroy them shortly after hatching and before much damage occurs. This method of control should not be attempted except when the caterpillars are in the tent.

The forest tent caterpillars can be destroyed when they collect on the trunks of trees, especially on warm days. This does not occur before the caterpillars are at least two weeks old. They can be destroyed by hand at this time by crushing or with an oil spray. Crushing is just as rapid and more economical than the oil spray. This control is feasible only when the caterpillars are clustered on the tree trunks.

Hand control methods are not feasible over extensive forested areas, but on ornamentals about the home, in parks, along roadways, in woodlots and

pastures, and other limited areas hand methods are more economical and effective than other methods of control.

Ecological. Spring weather is probably the most important natural check for the pests. Warm weather in April or early May that induces hatching followed by a week or more of cool weather frequently destroys the caterpillars. One or two such seasons are usually ample to reduce the pests to insignificant numbers. It is probable that weather is the dominant factor in production of the cyclic abundance of these pests.

LITERATURE CITED

- Baerg, W. J. 1935. Three shade tree insects, II. Great elm leaf-bettle, catalpa sphinx, and eastern tent caterpillar. Ark. Agr. Exp. Sta. Bul. 317:1-28.
- Baird, A. B. 1917. An historical account of the forest tent caterpillar and of the fall webworm in North America. 47th Ann. Rpt. Ent. Soc. Ont. 1916:73-84.
- Blackman, M. W. 1918. Apple tent caterpillar. Jour. Econ. Ent. 11:432-3.
- Britton, W. E. 1935. The eastern tent caterpillar. Conn. Agr. Exp. Sta. Bul. 378:65-82.
- Fiske, W. F. 1903. A study of the parasites of the American tent caterpillar. N. H. Agr. Exp. Sta. Tech. Bul. 6:182-230.
- Headlee, T. J. 1934. Cycles of abundance of the eastern tent caterpillar (*Malacosoma americana* Fabr.). N. J. Agr. Exp. Sta. Bul. 579:1-2.
- Hodson, A. C. 1939. Biological notes on the egg parasites of *Malacosoma disstria* Hbn. Ann. Ent. Soc. Amer. 32:131-6.
- Lutz, F. E. 1936. How about the tent caterpillar? Nat. Hist. 37:149-58.
- Lowe, V. H. 1898. Two destructive orchard pests. I. The apple tent caterpillar. N. Y. (Geneva) Agr. Exp. Sta. Bul. 152:279-97.
- Schaffner, Jr., J. V. & Griswold, C. L. 1934. Macrolepidoptera and their parasites from field collections in the northeastern part of the United States. U. S. Dept. Agr. Mis. Pub. 188:1-160.
- Swaine, J. M. 1913. Tent caterpillars. Dom. Canada, Div. Ent. Cir. 1:1-14.
- Sweetman, H. L. 1936. The biological control of insects. Comstock Pub. Co., Ithaca, N.Y.
- Tomlinson, Jr., W. E. 1938. Fluctuations in tent caterpillar abundance and some of the factors influencing it. Thesis (unpublished). Library of Mass. State College.
- Tothill, J. D. 1923. Notes on the outbreaks of spruce budworm, forest tent caterpillar, and larch sawfly in New Brunswick. Pro. Acadian Ent. Soc. 1922:172-82.
- Urbahns, T. D. 1930. Forest tent caterpillar numerous. Calif. Dept. Agr. Mon. Bul. 19:378.
- Wadley, F. M. 1938. The eastern tent caterpillar. U. S. Dept. Agr. Leaf. 161:1-4.
- Williams, L. T. 1916. Notes on the egg parasites of the apple tree tent caterpillar (*Malacosoma americana*). Psyche 23:148-53.

BOOK NOTICES

ELEMENTARY MICROTECHNIQUE.

By H. A. Peacock, Arnold & Co., London, England. Longmans, Green & Co., Toronto. Second Edition. Pages I-VIII and 1-330. 21 figures. 1940. Price \$2.75.

In this inexpensive volume, intended by the author to help fill the gap between the frequently all too sketchy undergraduate instructions and the more expensive references, the commoner methods employed in microtechnique are outlined in a simple manner, along with the principles involved. The customary chapter on the microscope includes a simple method of dark ground illumination. The chapters on technique include such subjects as paraffin embedding, methods for specific materials, formulae and hints, and sources, culture, and preservation of material.

Although this volume contains very little specific information on technical procedures for use with insect material, it is a handy little volume for those commencing microtechnique.

R. H. Ozburn.

AN INTRODUCTION TO ENTOMOLOGY.

By John Henry Comstock, Comstock Publishing Co., Ithaca, N.Y. Ninth edition, revised; 1064 pages; 1228 illustrations. 1940. Price \$5.00.

Students of Entomology generally will be grateful to Dr. G. W. Herrick for preparing this new edition. Probably no book published in North America has had more influence on the training of entomologists in the United States and Canada than the early editions of this work. The fact that it has gone through several editions indicates the place it occupies among entomologists. It is, indeed, much more than an introduction to entomology; it is by many, I feel sure, regarded as one of our most valuable guides and works of reference, as it contains information of value to all workers, regardless of age. During my many years of government service, a book which I have consulted freely is my copy of one of the earlier editions. It has helped me on many an occasion. Entomology is now recognized the world over as one of the more important of the natural sciences. Its development during the last few decades has been truly remarkable. In the future, it is fully expected that this development will be even more remarkable. In this progress, Comstock's "Introduction to Entomology" will assist in no small way in the education of students who decide to enter this field of research. It should, therefore, be available to all who make this decision.

Considerable additional information is included in the new edition. In view of the increasing interest in the subject of the biological control of insects, the discussions relating to parasitic species occurring in the Hymenoptera have been extended considerably. With these Dr. Herrick has had the assistance of Dr. Henry K. Townes.

In such an important work as this, we would like to have seen some of the older illustrations replaced by better ones, and, in the discussions of the Lepidoptera, changes in the names of species made to conform to those used in McDunnough's check list of the Lepidoptera of Canada and the United States. These, however, are minor matters. The important achievement is the publication of this new edition of a most valuable work, and for this we congratulate Dr. Herrick.

Arthur Gibson

INSECT TRANSMISSION OF PLANT DISEASES.

By J. G. Leach, McGraw-Hill Book Co., New York. Pages 1-XVIII and 1-615. 238 figures. 1940. Price \$6.00.

In the course of the past three decades, plant pathologists have become increasingly aware of the importance of insects in the spread and development of plant diseases. The literature of this period contains many references to the role of insects associated with individual plant diseases and groups of diseases. These references vary from a few lines crowded into a paper of a mycological or etiological nature to separate publications of an excellent character such as K. M. Smith's *Recent Advances in the Study of Plant Viruses* (1933). The present volume, however, is the first comprehensive effort to assemble the more pertinent facts relating to insect transmission of all types of plant diseases. The experience of the author, formerly professor of plant pathology at the University of Minnesota and at present head of the Department of Plant Pathology and Bacteriology at the University of West Virginia, has enabled him to evaluate these facts and interpret them from the standpoint of practical plant pathology without losing sight of their broad biological significance.

Of necessity the text matter is limited to facts concerning insect transmission so that much information concerning plant pathology and vectors has had to be omitted. The list of references at the conclusion of each chapter more

than compensates for the information omitted. Ready reference to the subject matter of this text is facilitated by arrangement of the chapters. The first four chapters consist of introductory matters such as an introduction, interrelationships of plants and insects, symbiosis between insects and micro-organisms and its significance in plant pathology, and the relation of insects to the spread and development of plant diseases. The next seven chapters are specific in character, dealing with plant diseases caused by toxicogenic insects; insects and bacterial, fungus, and virus diseases, and phytopathogenic protozoa; and mites, nematodes and other small animals as vectors of plant diseases. The last six chapters deal with subjects of general biological significance such as anatomy and physiology of insects and plants as pertaining to insect transmission of plant diseases; the inocula of plant pathogens and the feeding and breeding habits of insects in relation to insects transmission; comparison of animal and plant diseases transmitted by insects; and methods useful in the study of insect transmission of plant diseases. The inclusion of an appendix consisting of tables of causal organisms and vectors, vectors and diseases, comparisons of insect-transmitted plant diseases and transmission phenomena, and of animal and plant diseases, is a valuable feature.

This text book, in keeping with the McGraw-Hill standard of publications, bridges the gap between applied entomology and plant pathology and should prove an invaluable reference to all engaged in plant protection, whether economic entomologist or plant pathologist.

R. H. Ozburn.

RESEARCH NOTE

STOMIS PUMICATUS IN AMERICA (COLEOPTERA, CARABIDAE)

Recently I have been engaged in sorting some thousands of North American Carabidae loaned me for study by Mr. David Rockefeller. Among various native species from Quebec was one unexpected stranger, a single ♂ specimen of *Stomis pumicatus* (Panz.) labeled Hemmingford, Quebec, 31-VIII-1916, J. I. Beaulne. The species is a native of Europe, where it has a wide range, including Great Britain and Ireland.

The presence of this beetle in America is almost certainly due to introduction by man. (For discussion of other Coleoptera introduced in eastern Canada, see W. J. Brown, *Canadian Entomologist*, Vol. 72, 1940, pp. 65-78.) The Quebec specimen agrees well with several from Europe in the Museum of Comparative Zoology. By arrangement with Mr. Rockefeller, the specimen will be deposited in the American Museum of Natural History in New York.

The genus *Stomis* is previously unknown in America. It is an isolated member of the Pterostichini, distinguished from more typical members of the tribe by unhooked maxillae (cf. G. Horn, *Genera of Carabidae*, 1881, p. 137). It might perhaps be placed on our lists at the beginning of the Pterostichini, just before *Trigonognatha* (=Myas). Superficially, *Stomis pumicatus* resembles "*Platynus*" (*Oxypselaphus*) *obscurus* Hbst. more than anything else in our fauna, but it is slightly larger (6 to 8 mm.), differently proportioned, not pubescent, and with much longer, more conspicuous mandibles.

P. J. Darlington, Jr.,
Museum of Comparative Zoology, Cambridge, Mass.

GUELPH PRINTING SERVICE

Mailed Tuesday, December 31st, 1940.

Index to Volume LXXII

Achorotile albosignata Dahl., 88
 Acontia abdominalis Grt., 200.
 Acontia knowltoni n. sp., 199.
 Acronicta connecta albina n. var., 191.
 Acronicta oblongata, 191.
 Acronicta sagittata n. sp., 191.
 Aeschna canadensis Wlk., 10, 31.
 Aeschna eremita Scud., 8, 31.
 Aeschna interrupta Wlk., 8.
 Aeschna interrupta lineata Wlk., 31.
 Aeschna juncea americana Bart., 10.
 Aeschna sitchensis Hag., 10, 31.
 Aeschna umbrosa Wlk., 10.
 Aeschna umbrosa umbrosa Wlk., 31.
 Aetheopsylla n. gen., 41.
 Aetheopsylla septentrionalis n. sp., 42.
 Agrilus communis rubicola Ab., 21.
 Agrion angulatum Wlk., 30.
 Agrion interrogatum Selys., 7, 30.
 Agrion resolutum Hag., 7, 30.
 Agriotes obscurus L., 72.
 Agriotes sputator L., 72.
 ALEXANDER, CHARLES P., Article by, 151.
 Amalus haemorrhous Hbst., 77.
 Amphagriion abbreviatum Selys., 30.
 Amphitornus coloradensis ornatus Heb., 234.
 Anacamptodes albigenaria Wlk., 92.
 Anacamptodes defectaria Gn., 92.
 Anacamptodes perfectaria n. sp., 92.
 Anax junius Dru., 31.
 Anaxipha exigua Say, 15.
 Andrena campanulae Vier. & Ckll., 42.
 Anisandrus dispar Fab., 189.
 Anisandrus pyri Peck, in British Columbia,
 The Shot Hole Borer, 189.
 Anomogyna atrata ursae n. var., 197.
 Anomogyna atrata yukona McD., 197.
 Antepione thisoaria Gn., 102.
 Apache degeeri Kby., 88.
 Apharetra dentata Grt., 198.
 Apharetra purpurea n. sp., 199.
 Apharetra pyralis, 198.
 Aphodius erraticus L., 73.
 Aphodius fimetarius L., 73.
 Aphodius fossor L., 73.
 Aphodius haemorrhoidalis L., 73.
 Aphodius prodromus Brahm., 74.
 Aphodius scrofa Fab., 74.
 Aphodius scybalarius Fab., 73.
 Aphodius subterraneus L., 73.
 Apicia argillaria Hst., 101.
 Apicia confusaria, 101.
 Apicia distycharia Gn., 99.
 Apicia falcata Pack., 98.
 Apicia galbanaria Hst., 99.
 Apicia geniculata Hst., 101.
 Apicia packardaria n. sp., 100.
 Apicia subflavaria Pears., 99.
 Apicia terraria n. sp., 98.
 Apicia tibiaria n. sp., 102.
 Apicia venosaria n. sp., 101.
 Aprioria geniculata Chamb., 56.
 Argynnis of the Cariboo Region of British
 Columbia, 23.
 Argynnis aphrodite columbia Hy. Edw., 23.
 Argynnis atlantis beani B. & Benj., 24.

Argynnis atlantis hollandi n. race, 82.
 Argynnis bischoffii opis Edw., 25.
 Argynnis bremneri picta McD., 24.
 Argynnis cybele pseudocarpenterii n. race, 82.
 Argynnis hydaspe rhodope Edw., 24.
 Argynnis manitoba n. sp., 83.
 Argynnis nevadensis semivirida McD., 25.
 Arphia conspersa Scud., 17.
 Arphia pseudonietana Thom., 17.

Baetis alba Say, 109.
 Baetisca rogersi n. sp., 156.
 Baetisca thompsonae, 156.
 Barynotus obscurus Fab., 75.
 Barynotus schonherri Zett., 75.
 Basiaeschna janata Say, 8.
 BEALL, GEOFFREY, Article by, 45.
 Beetle, Genitalia, A Method of Mounting
 Small, 238.
 BEQUAERT, J., Article by, 52.
 BERG, V. L., Article by, 169.
 BERNER, LEWIS, Article by, 156.
 BLAISDELL, FRANK E., Sr., Article by, 212.
 Bolitophila buccaria n. sp., 48.
 Bolitophila duplus Garrett, 48.

BOOK NOTICES:

Bio-Ecology by F. B. Clement and V. E.
 Shelford, 108.
 The Chemistry and Toxicology of Insect-
 icides by Harold H. Shepard, 188.
 Compendium of Entomological Methods
 published by Ward's Natural Science
 Establishment, 128.
 Destructive and Useful Insects, Their
 Habits and Control by C. L. Metcalf and
 W. P. Flint, Second Edition, 44.
 Elementary Microtechnique by H. A.
 Peacock, 250.
 Fleas of Eastern United States by Irving
 Fox, 63.
 Insect Transmission of Plant Diseases by
 J. G. Leach, 251.
 An Introduction to Entomology by John
 Henry Comstock, Ninth Edition, 251.
 A Laboratory Guide in Entomology for
 Introductory Courses by Robert Mathe-
 son, 44.
 Meadow and Pasture Insects by Herbert
 Osborn, 19.
 Principles of Forest Entomology by Sam-
 uel Alexander Graham, 20.
 The Principles of Insect Physiology by
 V. B. Wigglesworth, 63.
 Brachycyrtus chrysopae n. sp., 86.
 Brachycyrtus from British Columbia, A New
 Species of, 85.
 Brachycyrtus nawali Ashm., 85.
 Brachyrhinus ligneus Oliv., 76.
 Brachyrhinus porcatius Hbst., 77.
 Brachyrhinus rugifrons Gyll., 76.
 Brachyrhinus singularis L., 76.
 Brachysomus echinatus Bonsd., 62, 75.
 Bradytus fulvus DeG., 69.
 BRAUN, ANNETTE F., Article by, 178.

BROWN, W. J., Articles by, 1, 65, 115, 161, 182, 230.

BUCKELL, E. R., Article by, 149.

Buotus n. gen., 58.

Buotus carolinus n. sp., 59.

Caberodes cayennaria Gn., 100.

Calligrapha confluens Schffr., 166.

Calligrapha knabi n. sp., 166.

Calligrapha rowena Knab., 166.

Calopteryx acquabilis hudsonica Ha., 6, 28.

Cannula pellucida Scud., 149, 233, 235.

Cantharidae and Chrysomelidae, Some New Species of, 161.

Carabus granulatus L., 69.

Carabus nemoralis Mull., 69.

Casnonia pennsylvanica L., 62.

Cassida rubiginosa Mull., 74.

Ceutorhynchus convexipennis Fall, 187.

Ceutorhynchus hearnei n. sp., 186.

Ceutorhynchus munki n. sp., 187.

Ceutorhynchus squamatus, 187.

CHAMBERLIN, RALPH V., Article by, 56.

CHERMOCK, F. H., Article by, 81.

CHERMOCK, R. L., Article by, 81.

Chilopods and Diplopods from North Carolina, On Some, 56.

Chlorocleptia felicitata imperialis B. & McD., 148.

Chlorocleptia jaegeri n. sp., 147.

Chlorocleptia simplex Smith, 148.

Chrysolina staphylea L., 74.

Chrysomelidae, Some New Species of Cantharidae and, 161.

Cicindela formosa gibsoni n. subsp., 182.

Cicindela formosa manitoba Leng, 182.

Cicindela scutellaris Say, 183.

Cleonus piger Scop., 77.

Coccinella undecimpunctata L., 72.

Coenonympha inornata, 130.

Coleophora, Aster and Goldenrod Seed-Feeding Species of, 178.

Coleophora bidens n. sp., 182.

Coleophora dextrella n. sp., 180.

Coleophora duplicis Braun, 180.

Coleophora ericoides Braun, 178.

Coleophora subapicis n. sp., 181.

Coleoptera Common to the European and North American Continents, Notes on the American Distribution of Some Species of, 65.

Coleoptera, Some New and Poorly Known Species of, 182.

Colias christina mayi form *marjorie* n. form, 82.

Colias christina mayi n. race, 81.

Colpocephalum laticeps Kell., 104.

Columbicola columbae Linn., 106.

Conocephalus strictus Scud., 16.

Cordula shurtleffi Scud., 10, 32.

Corrections, 20.

Crane-Flies (Tipulidae, Diptera) Part XIV, New Nearctic, 151.

Crenitis maculifrons n. sp., 183.

Curtanotus aulicus Panz., 69.

Cyphelophorus tuberculatus Gyll., 3.

Dasycosymbia boweri n. sp., 145.

Dasycosymbia gracilata Grossb., 146.

Degeeriella fusca Nitz., 106.

Deleaster dichrous Grav., 72.

Delphacodes kilmani V. D., 88.

Delphacodes pellucida Fab., 88.

Diastrammen marmorata, 16.

Diaulences pulchryses Cwfd., 20.

Diaulinus pulchripes Cwfd., 20.

Dicranota (*Plectromyia*) *confusa* Alex., 154.

Dicranota (*Plectromyia*) *townesi* n. sp., 154.

Dicranota (*Rhaphidolabis*) *cayuga* Alex., 154.

Diplopods from North Carolina, On Some Chilopods and, 56.

Dolichopsyllidae (Siphonaptera) from Canada, A New Genus of the Family, 41.

D'ORCHYMONT, A., Article by, 1.

DOS PASSOS, CYRIL F., Article by, 167.

DUNCAN, JAMES B., Article by, 89.

Egg Deposits of a type not usually Produced by *Melanoplus mexicanus mexicanus* (Sauss.) in Manitoba, 235.

EMERSON, KARY C., Article by, 104.

Enallagma boreale Selys., 7, 29.

Enallagma carunculatum Morse, 30.

Enallagma civile Hag., 30.

Enallagma clausum Morse, 28.

Enallagma cyathigerum Charp., 7, 29.

Enallagma hageni Walsh, 29.

Entomological Society of British Columbia, 128.

Epauleocus unicolor Pill., 118.

Ephemera virgo Oliv., 109.

Ephoron leukon Will., 109.

Ephoron, The Genus, 109.

Erioptera (*Erioptera*) *chlorophylloides orthomera* n. subsp., 155.

Erioptera (*Erioptera*) *leptostyla* n. sp., 154.

Euchlaena vinulenteria v. *ochreaaria* n. var., 93.

Euchloe ausonides mayi n. race, 81.

Eucosma landana Kft., 243.

Eupithecia albimontanata n. sp., 36.

Eupithecia balboata C. & S., 39.

Eupithecia bindata Pears., 35.

Eupithecia diegata n. sp., 37.

Eupithecia graefi Hlnt., 39.

Eupithecia joymaketa, 39.

Eupithecia longidens Hlnt., 35.

Eupithecia maestosa Hlnt., 37.

Eupithecia niveifascia Hlnt., 37.

Eupithecia Notes, 35.

Eupithecia palpata Pack., 36.

Eupithecia pinata Cass., 39.

Eupithecia plenoscripta Hlnt., 35.

Eupithecia scabrogata Pears., 39.

Eupithecia sierrae joymaketa, 39.

Eupithecia spermaphaga Dyar, 40.

Eupithecia togata v. *columbrata* var. nov., 40.

Eupithecia zygadaeniata Pack., 37.

Euxostus alienus n. sp., 119.

Euxoa altera n. sp., 196.

Euxoa atropulverea Sm., 195.

Euxoa bicollaris, 193.

Euxoa brevipennis Sm., 192.

Euxoa henrietta Sm., 192.
Euxoa immixta Grt., 193.
Euxoa incallida Sm., 196.
Euxoa inyoca Benj., 193.
Euxoa luteotincta n. sp., 195.
Euxoa medialis rufosuffusata n. var., 195.
Euxoa misturata, 193.
Euxoa permixta n. sp., 193.
Euxoa scotogrammoides McD., 195.
Euxoa spumata n. sp., 192.
Euxoa unica n. sp., 192.
Euxoa vulpina Sm., 196.
Exentera apriliana Grote, 243.
 External Morphology of the Immature Stages of the bee fly, *Systoechus vulgaris* Loew, A Predator of Grasshopper Egg Pods, The, 169.

Fecundity and Longevity in *Microcryptus basizonius* Grav., A Note on the Effect of Certain Foods upon, 236.

FINLAYSON, L. R., Article by, 236.

Fornax canadensis n. sp., 184.

Fornax molestus Bov., 184.

Fornax orchesides Newm., 184.

Fossil, *Helophorus arcticus* Brown, A Living, 1.

FREEMAN, T. N. Articles by, 129, 206.

Galenara errantaria n. sp., 90.

GARLICK, W. G., Article by, 21.

GAUL, A. T., Article by, 240.

Geometridae from the Southwest, Two Apparently Undescribed Species of, 145.

Geometridae with Notes, III, New North American, 90.

Geotrupes stercorarius L., 74.

Grasshoppers, The Effect of Hailstorms on, 233.

GREEN, THELMA, Article by, 236.

HANDFORD, R. H., Article by, 235.

HARMSTON, F. C., Article by, 111.

HEINRICH, CARL, Article by, 242.

Helophorus aquaticus L., 70.

Helophorus arcticus Br., 1.

Helophorus (Cyphelophorus) tuberculatus Gyll., 1.

Helophorus wandereri, 3.

Heterodoxus longitarsus Piag., 104.

HOLLAND, G. P., Article by, 41.

Homohadena badistriga tenuistriga n. var., 197.

Homoneura armata Shew., 86.

Homoneura cactifera, 86.

Homoneura praeapicalis Shew., 86.

Homoneura setitibia, 86.

Hydriomena albimonata, 20.

Hydriomena albimontana n. sp., 20.

Hypera meles Fab., 77.

Hypera nigritrostris Fab., 77.

Hypera punctata Fab., 77.

Incisalia doudoroffi n. sp., 168.

Incisalia eryphon Bdv., 167.

Incisalia from Southern California, A New Species of, 167.

Incisalia iroides Bdv., 167.

Incisalia mossii Hy. Edw., 167.

Incisalia schryveri Cross, 167.

Ixala adventaria Pears., 147.

Ixala desperata Hlst., 147.

Ixala klotzi n. sp., 146.

Ixala proutearia Cass., 147.

KNOWLTON, G. F., Article by, 11.

Laccornis conoides Lec., 126.

Laccornis deltoides Fall, 127.

Laccornis difformis Lec., 126.

Laccornis latens Fall, 126.

Laccornis lugubris Aube, 127.

Laccornis oblongus Steph., 127.

Laccornis pacificus n. sp., 123, 126.

Laccornis, with a Key to the Nearctic Species, Description of a New Species of, 122.

Lacinipolia agnata Sm., 197.

Lacinipolia prognata n. sp., 197.

LANGE, W. H. Jr., Article by, 84.

Lasiotrechus discus Fab., 69.

LEECH, HUGH B., Article by, 122.

Lepidoptera from the Riding Mountains and Sand Ridge, Manitoba, Some New Diurnal, 81.

Lepidopterus plantagenaria, 146.

Lestes congener Hag., 6, 28.

Lestes disjunctus Selys., 6, 28.

Lestes forcipatus Ramb., 28.

Lestes unguiculatus Hag., 28.

Leucorrhinia borealis Hag., 12.

Leucorrhinia glacialis Hag., 13, 34.

Leucorrhinia hudsonica Selys., 12, 34.

Leucorrhinia patricia n. sp., 12.

Leucorrhinia proxima Calv., 13, 34.

Libellula quadrimaculata L., 11, 32.

Listrus bifasciatus Blais., 213.

Listrus extricatus Csy., 213.

Listrus from Cajon Pass, California, A New Species of, 212.

Listrus hoppingi n. sp., 212.

Listrus motschulskii LeC., 213.

Listrus pardalis Csy., 213.

Longevity in *Microcryptus basizonius* Grav., A Note on the Effect of Certain Foods upon Fecundity and, 236.

Lycæna dorcas from Northeastern New

Brunswick, A New Race of, 130.

Lycæna dorcas v. *dos Passosi* n. var., 130.

Macrobasis fabricii LeC., 231.

Macrobasis flavocinerea Blatch., 231.

Macrobasis murina Lec., 232.

Macrobasis subglabra Fall, 232.

Macrobasis unicolor Kby. and Some Allied Species, On the Identity of, 230.

Malacosoma americana Fab., 245.

Malacosoma distria Hbn., 245.

Mallophaga from Oklahoma Hosts, Records of, 104.

- MATHERS, WM. G., Article by, 189.
 Mayfly from Northern Florida, *Baetisca rogersi*, A New, 156.
 McDUNNOUGH, J., Articles by, 23, 35, 59, 90, 130, 191, 243.
Mecistocephalus maxillaris Gerv., 56.
Melanolophia imitata v. *barbara* n. var., 90.
Melanoplus differentialis Thom., 18.
Melanoplus mexicanus mexicanus Sauss., 149, 235.
Melanoplus packardii Scud., 18.
Melanoplus stonei Hehn, 18.
Melanoplus viridipes Walsh, 18.
Meris Hlst., 96.
Meris suffusaria n. sp., 96.
Mezium americanum Lap., 117.
Microcryptus basizonius Grav., 236.
 MIDDLEKAUFF, WOODROW W., Article by, 201.
 Misused Generic Name (Lepidoptera Olethreutidae), Correction of a, 242.
Molophilus (*Molophilus*) *novacaesariensis* Alex., 155.
Molophilus (*Molophilus*) *sparus* n. sp., 155.
 Montreal Branch, Entomological Society of Ontario, Report of the, 43.
Mycetophila fungorum var. *obscura* Fisher, 50.
Mycetophila quatuornotata Lw., 48.
Mycetophila subquatuornotata n. sp., 48.
Mycetophila thioptera n. sp., 48.
 Mycetophilidae, Some New, 48.
Mycomyia imitans, 51.
Mycomyia kiamichii n. sp., 50.
Mycomyia tantilla Lw., 50.

Nampabius carolinensis Chamb., 56.
Nannaria conservata n. sp., 56.
Nehalennia irene Hag., 7, 30.
Nemobius carolinus, 15.
Nemobius maculatus Blatch., 15.
Neoconocephalus lyristes R. & H., 16.
Ncoolcanabates orbitalis, 219.
Nepytia disputata n. sp., 94.
Nepytia regulata B. & McD., 94.
Neurotoma crataegi n. sp., 202.
Neurotoma fasciata Nort., 205.
Neurotoma inconspicua Nort., 206.
Niptus hololeucus Fald., 118.
 Noctuid from the Desert Region of Southern California, A New, 147.
Nopoiulus minutus Brandt, 58.

 Odonata from the Patricia Portion of the Kenora District of Ontario with Description of a New Species of *Leucorrhinia*, 4.
 Odonata of Saskatchewan, A Preliminary List of the, 26.
Odynerus annulatus Say, 53.
Odynerus dorsalis var. *balteatus* Say, 54.
Odynerus dorsalis var. (or subsp.) *stricklandi* new, 55.
Odynerus (*Rygiichium*) *dorsalis* Fabricius, Variation in the North American, 52.

Odynerus sulphureus de Sauss., 55.
Oeneis jutta ridgiana n. race, 82.
 Oil Sprays in Grasshopper Control in British Columbia, The Use of, 149.
Olarius franciscanus Stal., 87.
Onthophagus nuchicornis L., 72.
Ophiogomphus colubrinus Selys, 10.
Ophiogomphus severus Hag., 31.
Orthomorpha gracilis Koch, 56.
 Orthoptera in Ontario, New Records and Notes of, 15.
Oscinella beameri n. sp., 221.
Oscinella coxendix Fitch, 215.
Oscinella frit L., 226.
Oscinella frontella Fall., 230.
Oscinella fronto-orbitalis n. sp., 221.
Oscinella gigas n. sp., 224.
Oscinella grandissima n. sp., 226.
Oscinella grisea n. sp., 227.
Oscinella halterata, 225.
Oscinella hesperia n. sp., 219.
Oscinella lugubria n. sp., 225.
Oscinella luteiceps n. sp., 222.
Oscinella neocoxendix n. sp., 215.
Oscinella nudiuscula Lw., 223.
Oscinella ochripes n. sp., 218.
Oscinella painteri n. sp., 223.
Oscinella triorbiculata n. sp., 229.
Oscinella, Twelve New North American Species of, 214.

Papilio polydamas L., 188.
Papilio polydamas lucayus R. & J., 188.
Parajulus pennsylvanicus Brandt, 58.
Paroxya floridana Thom., 18.
Paroxya hoosieri Blatch., 18.
Peronea bowmanana McD., 60.
Peronea busckana McD., 60.
Peronea caliginosa Wlk., 60.
Peronea celiana Fern., 60.
Peronea chalybeana Fern., 60.
Peronea cornana McD., 61.
Peronea fuscana B. & Bsk., 61.
Peronea hudsoniana Wlk., 60.
Peronea kearfottana McD., 61.
Peronea maccana Tr., 59.
Peronea maculidorsana Clem., 60.
Peronea nivisellana Wlsh., 61.
Peronea oka agana n. sp., 61.
Peronea with Description of a New Species, Notes on the Genus, 59.
 Phalaenidae, Undescribed Species and Races of, 191.
Philopodon plagiatum Schatl., 76.
Philoaterus subflavescens Geoff., 105.
Phthiria catawbiensis n. sp., 50.
Phthiria tanypus, 50.
Phyciodes nycteis reversa n. race, 83.
Phyllodinus nervatus V. D., 88.
Pissonotus aphidoides V. D., 88.
Pissonotus basalis V. D., 88.
Platynus ruficornis Goetz, 70.
Platyptilia albertae B. & L., 85.
Platyptilia, An Apparently New Alaskan, 84.
Platyptilia johnstoni n. sp., 84.
Platyptilia pallidactyla Haw., 84.
Platyptilia petrodactyla Wlk., 84.
Platyptilia washburnensis McD., 85.

Platysamia columbia Sm. in the Ottawa Region, Notes on the Occurrence of, 129.

Platysamia gloveri Str., Hibernation Peculiarities of, 89.

Platysamia rubra Behr., 89.

Pleurogeophilus varians McN., 56.

Poanes hobomok ridingsii n. form., 83.

Podabrus deceptus n. sp., 161.

Podabrus heteronychus Fall., 161.

Podabrus obscurevittatus, 162.

Podabrus perplexus n. sp., 161.

Podabrus probus Fall., 161.

Podabrus puberulus Lec., 162.

Podabrus secretus n. sp., 161.

Polemium canadensis n. sp., 162.

Polemium laticornis Say, 162.

Polistiphaga arvalis Cresson, A Note on the Biology of, 240.

Polistes fuscatus Fabr., 240.

Polistes fuscatus pallipes Lep., 240.

Polyphylla decemlineata Say, 185.

Polyphylla hammondi Lec., 185.

Polyphylla perversa Csy., 186.

Polyphylla variolosa Hentz., 185.

Prionocyphon limbatus Lec., 62.

Pristonychus terricola Hbst., 69.

Prochaerodes forficaria Gn., 103.

Prochaerodes forficaria v. *combinata* n. var., 103.

Prochaerodes nubilata Pack., 103.

Pseudexentera caryana n. sp., 243.

Pseudexentera from Hickory, A New, 243.

Pseudexentera n. gen., 243.

Pseudophonus rufipes DeG., 70.

Pseudopomala brachyptera Scud., 16.

Pteromalus puparum L., 62.

Ptinidae Occurring in Dwellings and Warehouses in Canada, A Key to the Species of, 115.

Ptinus bicinctus Sturm., 121.

Ptinus brunneus Duft., 121.

Ptinus fur L., 121.

Ptinus latro Fabr., 122.

Ptinus ocellus Br., 120.

Ptinus pilosus White, 120.

Ptinus raptor Sturm., 121.

Ptinus tectus, 120.

Ptinus villiger Reit., 120.

Randomization in Field Work, The Technique of, 45.

RESEARCH NOTES:

Additional Fulgoridae Taken in Alberta, 87.

Additional Notes on *Strymon acadica* Edw., 43.

The Migration of Codling Moth Larvae from One Apple to Another, 87.

A Note on the Habits of Mature Codling Moth Larvae, 87.

Notes on *Andrena campanulae* Vier. & Ckll., 42.

Notes on Some Recent Additions to the Insect Collections of the Quebec Plant Protection Service, 61.

On the Occurrence of *Papilio polydamas*

Linnaeus within the United States, 188.

Preoccupied Names in the Genus

Homoneura, 86.

Stomis pumicatus in America, 252.

The Transformation of Data from

Entomological Field Experiments, 168.

Riker Insect Mount for Use in Teaching, Modified, 209.

Rose Stem Girdler, *Agrilus communis rub-bicola* Ab., Notes on the, 21.

SABROSKY, CURTIS W., Article by, 214.

Sawflies of the Genus *Neurotoma*, The Nearctic, 201.

Sciaphilus asperatus Bond., 75.

Scolops grossus Uhl., 87.

Septis ampliata n. sp., 199.

SHAW, FRANK R., Article by, 48.

Shot Hole Borer, *Anisandrus pyri* Peck, in British Columbia, 189.

Sigiria scorpion Chamb., 56.

Silis freemani n. sp., 163.

Sitona cylindricollis Fabr., 77.

SMITH, RALPH H., Article by, 209.

Somatochlora albicincta Burm., 11.

Somatochlora cingulata Selys., 11.

Somatochlora franklini Selys., 11, 32.

Somatochlora hudsonica Hag., 11.

Somatochlora minor Calv., 11, 32.

Somatochlora whitehousei Wlk., 32.

Somatolophia haydenata Pack., 97.

Somatolophia pallescens n. sp., 97.

Somatolophia umbripennis Hst., 97.

Sparganothis hudsoniana n. sp., 206.

Sparganothis putmanana n. sp., 208.

Sparganothis, Two Apparently New Canadian Species of, 206.

SPENCER, G. J., Article by, 233.

SPERRY, GRACE H., Article by, 147.

SPERRY, JOHN L., Article by, 145.

Sphaeridium bipustulatum Fab., 71.

Sphaeridium lunatum Fab., 71.

Sphaeridium scarabaeoides L., 70.

SPIETH, HERMAN T., Article by, 109.

Spharagemon collaræ Scud., 17.

Staphylinus globulifer Fourc., 72.

Stenocranus arundineus Met., 88.

Stenoporpia graciella n. sp., 91.

Stenoporpia purpuraria B. & McD., 91.

Stenoporpia separataria Grt., 91.

Stenoporpia vernalis n. sp., 91.

Stenoporpia vernata B. & McD., 91.

STEWART, M. A., Article by, 41.

Stilpnotia salicis L., 61.

Stomis pumicatus Panz., 252.

Stream Bottom and its Effect on the Insect Fauna, Modification of a, 131.

Striaria causeyae n. sp., 58.

Strophosoma melanogrammum Forst., 75.

Strymon acadica Edw., 43.

Strymon acadica watrini Duf., 43.

SWANK, GEORGE R., Article by, 238.

SWEETMAN, HARVEY L., Article by, 245.

Sympetrum corruptum Hag., 33.

Sympetrum costiferum Hag., 34.

Sympetrum danae Sulz., 12, 34.

Sympetrum decisum Hag., 12, 33.

Sympetrum madidum Hag., 33.

Sympterus obtusum Hag., 11.
Synanthedon tipuliformis L., 21.
Syndipnus alaskensis n. sp., 138.
Syndipnus, A Synopsis of the North American Species of, 135.
Syndipnus gaspesianus Prov. n. comb., 143.
Syndipnus lateralis Grav., 137.
Syndipnus pannicularius Holmg., 138.
Syndipnus probatus n. sp., 144.
Syndipnus rubiginosus n. sp., 140.
Syndipnus ungavae n. sp., 139.
Syneta carinata Mann., 164.
Syneta extorris n. sp., 165.
Syneta pilosa n. sp., 164.
Systoechus vulgaris Lw., 169.

Tachycines asynamorus Adel., 16.
Tachytrechus olympiae Ald., 114.
Tachytrechus sanus O. S., 115.
Tachytrechus spinitarsis V. D., 115.
Tachytrechus Studies, 111.
Tachytrechus tahoensis n. sp., 144.
Tachytrechus utahensis n. sp., 112.

Tent Caterpillars, *Malacosoma americana* Fabr. and *Malacosoma disstria* Hbn., The Value of Hand Control for the, 245.

Tetracis cachexiata Gn., 102.
Tetragoneuria spinigera Selys., 11, 32.
 Thermo-Regulator to Control Variable Temperatures, An Adaption of a Standard Bi-Metallic, 78.

Tipula (*Lunatipula*) *disjuncta* Wlk., 154.
Tipula (*Lunatipula*) *marianae* n. sp., 153.
Tipula (*Tipula*) *nebulinervis* n. sp., 152.
Tipula (*Tipula*) *tennessa* Alex., 153.
Tipula (*Yamatotipula*) *brevifurcata* Alex., 152.

Tipula (*Yamatotipula*) *iroquois* Alex., 152.
Tipula (*Yamatotipula*) *manahatta* Alex., 153.
Tipula (*Yamatotipula*) *succincta* n. sp., 151.
Trachyphloeus bifoveolatus Bec., 77.
Trechus rubens Fab., 69.
Trichonta hansonii n. sp., 50.
Trichonta sagana n. sp., 51.
Trichonta venosa Staeg., 51.
Trichonta vulgaris Lw., 51.
Tridactylus minutus Sauss., 16.
Trigonogenius globulus Sol., 117.
Trinoton querquidulae Nitz., 104.
Tropiphorus obtusus Bonsd., 74.
Tropiphorus tomentosus Mahm., 74.
Tynopus n. gen., 57.
Tynopus dux n. sp., 57.

URQUHART, F. A. Article by, 15.

WALKER, E. M., Articles by, 4, 15, 26.
 WALLEY, G. STUART, Articles by, 85, 135.
 WENE, GEORGE, Articles by, 131.
 WICKLIFF, E. L., Article by, 131.
 WISHART, GEO., Article by, 78.

X. phydria maculata Say, 61.

Yermoia n. gen., 93.
Yermoia perplexata n. sp., 93.

Zale confusa n. sp., 201.
Zale curema Sm., 200.
Zale metata Sm., 200.
Zale obliqua Gn., 200.
Zale squamularis Dru., 200.

Ohio Jour.
 Ent. Soc.

CH

C

D

CI

S

I

Z

Stt

V

1940

52.
153.
151.

135.

new.
of

6
CH

C

P

CI

S

I

2

Stt

ne